GEOGRAPHIC

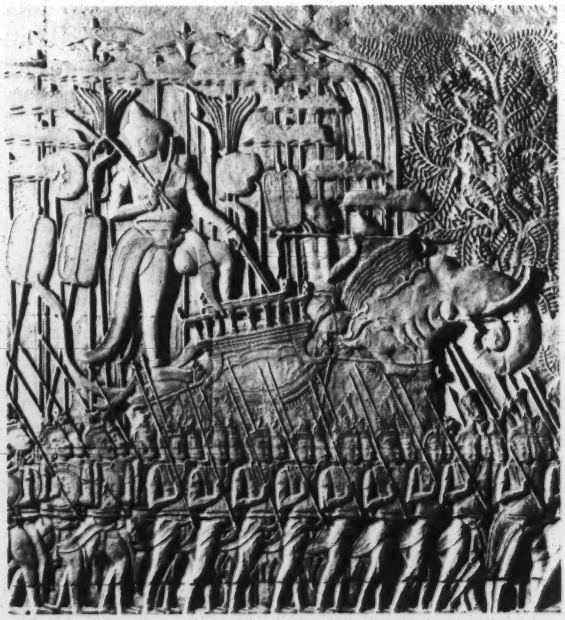
THE NATIONAL GEOGRAPHIC SOCIETY, WASHINGTON 6, D.C.

MAY 16, 1960 • VOLUME 38 • NUMBER 30 . . . *To Know This World, Its Life*

BANYAN ROOTS of Cambodian jungle clutch a giant stone Buddha that graced Angkor temple

LAST ISSUE UNTIL FALL
See page 357 for renewal

UMI



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the beginning of the Christian Era. They were brash and warlike when their civilization was young. They fought each other until, in the 9th century, their first powerful king forged two states—one around the lower Mekong Delta, one farther inland—into a single, powerful kingdom, Kambuja, or Kambujadesa, from which we get the Westernized form, Cambodia.

Yasovarman I soon started the building boom that climaxed in the architectural splendor of Angkor Wat (City Temple), under construction below. Details for these paintings were provided by Khmer reliefs, similar to that above, that cover temple walls.

Yasovarman founded his capital in 889 near the northern shore of Tonle Sap (Sea of Sweet Water) and called it Yasodharapura. We know it now as Angkor Thom (Great City).

PAINTINGS BY MAURICE FIÉVET; PHOTOGRAPHS COVER AND ABOVE, W. ROBERT MOORE, NATIONAL GEOGRAPHIC STAFF

UMI

Angkor Reborn

ATTENDED BY HIS spearmen, priests, and umbrella bearers, helmeted King Yasovarman I selects the site for his palace. He has already built the hilltop shrine on which he stands, and has cut a four-mile-long irrigation reservoir (background) to catch and store the life-giving water of the monsoon rains.

His successors added to his royal city until they constructed a Rome for Southeast Asia—Angkor, deep-set in the Cambodian jungle. Here a million people worked, played, and prayed until one day their neighbors swooped down and emptied the city that was some five centuries building.

Then for 400 years, only wild beasts lived in the city where gold-ornamented carriages wheeled and emperors rode elephants. Bats nested among the stones of once-holy shrines. Tree roots split walls and roofs. Snakes coiled where royal ballets performed. The jungle choked the great metropolis.

A century ago French naturalist Henri Mouhot, traveling by foot and canoe, came upon the ruins of a fabulous "lost city" of which he had heard. When he asked Cambodians living near by who had built it, the awe-struck rice farmers answered: "It is the work of giants," or "It made itself." Even today a pilgrim will tell you: "Only the gods could do so much."

A century of work pushed away the jungle and the veil of mystery. We now know that Angkor was the capital of a great empire which dominated much of Southeast Asia for six centuries.

Its people were called Khmers. They emerged in what is now Cambodia about

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The carvings depict kings and priests in their ceremonies, as well as heavenly dancers treading lotus blossoms. More revealing are the scenes of daily life.

Women gossip in the market place piled high with fruit and fish. Men gamble and match fighting cocks. The circus below was painted from wall carvings on the Bayon.

Fishermen lower their nets to the water. Forest campers drop a pig into a cooking pot. Their companions boil rice and roast fish on a spit.

Jayavarman VII was the last of the builder-kings. After his reign, old age overtook the empire. For 200 years nothing of importance was built. The god-kings lived in luxury and performed their sacred duties, but their power declined.

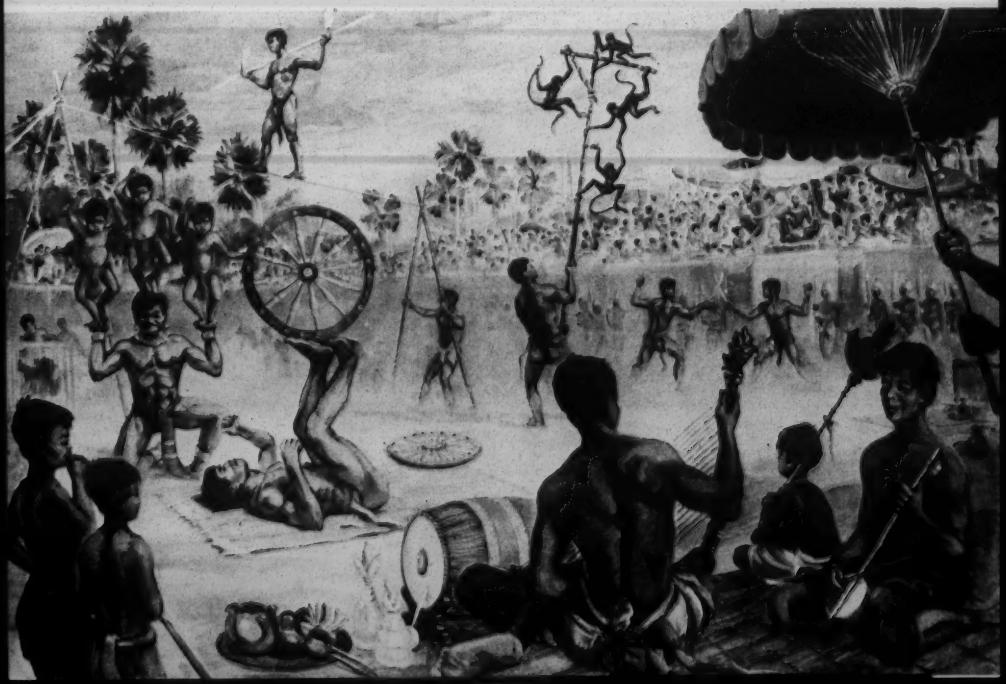
While the stature of the Khmers shrank, that of their neighbors—Thai, Annamese, and Lao—grew. In 1431 Thai looted the city. A year later the Khmers abandoned Angkor.

When the world-girdling empires of Europe were formed, France controlled Cambodia, taking over the area in the 1860's and naming it Indochina. Japan conquered it in 1941. After World War II the French returned, but soon left for good, pushed by nationalist and Communist pressures. Cambodia regained its independence in 1949.

Today a traveler can see many living counterparts of the reliefs on the walls of the Bayon. Female descendants of the Khmers still gossip in the market place. Men fish with the same circular nets. Oxcarts, like those frozen in stone, lumber along bush trails, their wheels screeching on dry axles. Farmers cut weeds with knives that match the weapons of the soldiers parading in stone.

Lands which Khmers so ingeniously irrigated feel the weight of bulldozers and concrete mixers as old reservoirs and canals are reconstructed, often with United States aid.

For their New Year celebration in April, Cambodians return to the old temples. "As I stood in one of the vast stone structures, watching the candle-bearing pilgrims and listening to the distant *poom-poom* of a native drum," writes W. Robert Moore in "Angkor, Jewel of the Jungle," in the April, 1960, *National Geographic*, "I could almost forget that Angkor had ever been deserted." L.B.



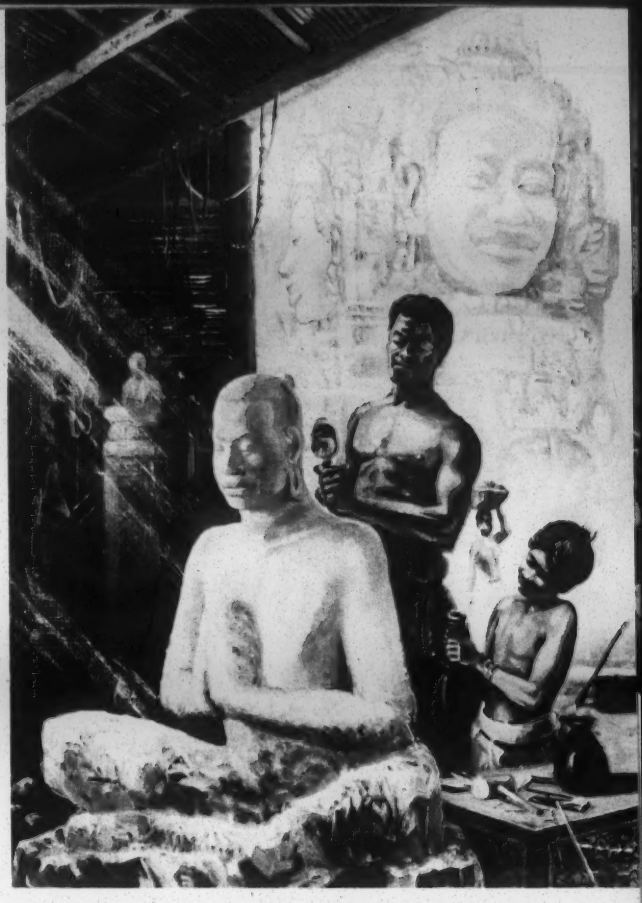
UMI

He straightened the Siem Reap River and made it form the eastern moat of his capital. He dug canals to hem the city's other sides. Within the six-square-mile area he had laid out, Yasovarman built hundreds of pools.

Kambuja is a land of seasonal rains and dry spells that last for months.

Each new king added new links to rivers, reservoirs and temple moats until a vast and complex water system nourished a great rice-based civilization.

Some of their canals, which also served as roads, ran arrow-straight for 40 miles. With this remarkable irrigation system, they could harvest two and sometimes three crops a year.



Most of the Khmer rulers were Hindus. They considered themselves partners with the Hindu deities and identified themselves as god-kings.

The temples they built were mountains of stone. For according to Khmer symbolism, the temple *was* a mountain —a replica of the mythological Mount Meru where the Hindu gods lived. Angkor Wat, the masterpiece of the Khmer capital, was designed as a house for the gods and a funerary temple for the king's ashes.

The greatest builder of all was Jayavarman VII who ruled Angkor when Richard the Lionheart ruled England. He ousted invading Chams, whose kingdom, Champa, occupied part of present Viet Nam, and whose fleets had sailed up the Mekong and pillaged the Khmer capital. King Jayavarman expanded the Khmer Empire to its farthest reaches, including parts of Malaya, Thailand, Laos, and North and South Viet Nam.

Unlike most of his predecessors, he was a Buddhist. He scattered faces of Buddha, like the one on the cover, on towers and gateways throughout the capital. But mindful of his god-king heritage, he mixed his own features with those of the holy one. The artist above sculpts his monarch wearing the same slight smile as the figure on the tower behind.

Jayavarman reconstructed the capital, replacing wooden walls with thick stone. Living well into his 90's, he built 102 hospitals plus many shrines, temples, and monasteries. He laid roads and magnified outlying cities.

His greatest accomplishment was the Bayon, a temple second in size only to Angkor Wat. From the reliefs carved on its walls—warm, intimate glimpses of life in Kambuja—we have been able to piece together much about the Khmers.

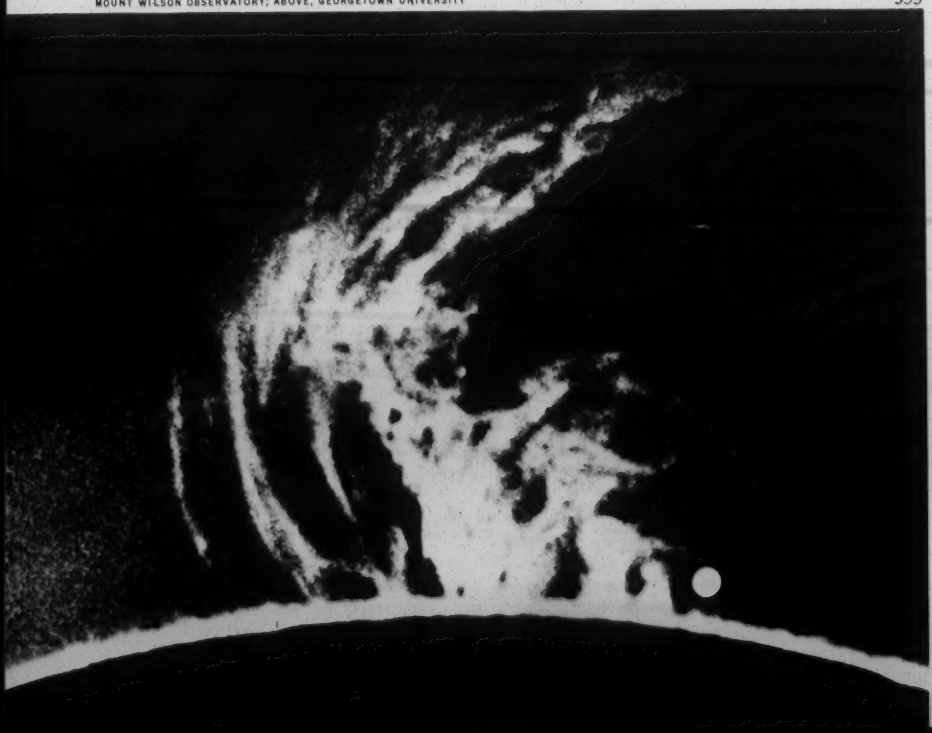
constitution and possible splitting, became known. It is believed that the sun is a huge atomic furnace, operating by fusion, the process of the H-bomb. To a layman's eye, the process is as complicated as the sun is hot. Reduced to its simplest terms, it works like this: In the violent heat and light of the sun, atoms of hydrogen are constantly changed into atoms of helium. When four hydrogen atoms combine, they produce one helium atom and a little left over. This leftover matter, about 1 per cent of the original total, is changed into light and heat. It is estimated that this process eats up the sun's matter at a rate of four million tons a second.

So when will the sun "go out," and with it all life in the solar system? Don't worry about it, there's enough material there to keep it burning at its present rate for some 35 billion years.

Light produced in the atomic reaction speeds across the 93 million miles from the sun to earth at 186,284 miles a second, reaching Earth eight minutes after it was made. It is in the shape of ultra-tiny particles called photons, which vibrate as they rush toward Earth. As you read this page, photons from the sun, or from an electric or other lamp, are falling on it. The black ink of the letters absorbs most of the photons that strike, changing their energy into heat. The white paper reflects the photons, some of which enter your eye, are focused by its lens, and fall on nerve endings that transmit the pattern of light and dark to the brain. (New uses of the photons' energy are described on page 359.)

So the sun, which appears to the naked eye (never look at it except through a cloud layer, a piece of smoked glass, or at dawn and sunset) to be a calm disk, is really a seething caldron, throwing out the light and heat we live by. From the great boiling tumult of the sun, immense streamers of burning gas, called prominences, spurt up occasionally at speeds up to 250 miles per second. They commonly reach heights of 250,000 miles. The photograph below shows one of these gas jets, photographed during an eclipse. The tiny round dot represents Earth on the same scale. F.S.

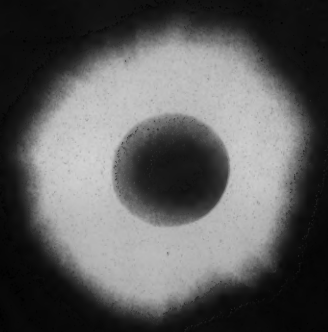
MOUNT WILSON OBSERVATORY; ABOVE, GEORGETOWN UNIVERSITY



UMI

The Solar System, No. 11

THE SUN



BIGGER, BRIGHTER, hotter, and busier than is easily understandable, our sun by its weight holds the solar system together, by its heat supports all life we know, and by burning produces all energy on Earth.

The sun is a star—and not a very big one as stars go. Yet it is 865,000 miles across—109 times the diameter of Earth. Its volume is fantastic: 337,000 million million cubic miles. Earth would fit into it 1,306,000 times.

The sun is so bright that an arc light such as is used in professional movie projectors would appear black against it. From measurements of the light falling on Earth, corrected to allow for that lost in our atmosphere, and remembering that Earth occupies only a tiny spot in the space around the sun, scientists have worked out that each square inch of the sun's surface produces some 1,500,000 candlepower constantly. When you think of the number of square inches on this huge globe, the total energy output is almost incomprehensible. And there is additional output that is not in the spectrum of visible light.

What is this mighty furnace made of and how is it fueled? The elements of the sun are the same elements we find on Earth, but under stresses of pressure and heat that are completely beyond any man-made power, including that of the H-bomb. The best reading for the sun indicates a surface temperature of 11,000° Fahrenheit. But the heat increases rapidly toward the center where calculations indicate it must reach 35 million degrees. Under these conditions, our Earthly vocabulary is close to useless to describe the state of things.

At such temperatures, all elements should be vaporized into gas. So they are, but because of the size and immense gravity of the sun, these gases are compressed into something denser than the heaviest metals we know.

Away from the center, the sun's gases thin out in layers, until the last layer, the corona, stretches out around the sun at least a distance equal to the solar diameter and sometimes, in jets, 10 times as far. This immense halo of pearly light can be seen only during a total eclipse (photograph above) because the sun's brightness outshines it so greatly. We know relatively little about the corona, since until recently it was possible to observe it only during these few minutes each year when the moon was directly in front of the sun. Refined viewing techniques, however, now make it possible to study the corona—or at least the part closest to the sun—without waiting for an eclipse. Unlike the gaseous atmosphere between corona and the surface of the sun, the corona is extremely thin—with much less matter in it than the best Earth-made vacuum. Comets whirl through it without being affected.

How the sun gets its power baffled men until the secrets of the atom, its

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Harnessing the Sunlight

FOR CENTURIES, man has sought to unlock the energy in a shaft of sunlight. He usually must take his solar energy secondhand. The fuels he burns—coal, oil, and natural gas—all began as plants. They converted and stored sunlight and then were fossilized into their present form. Sun's strength, filtered through plants and animals, makes man's food.

But plants are inefficient users of sunlight. What scientists seek, and are finding, are ways to reap this golden harvest firsthand. It should be a bumper crop. The sunlight striking a 100-square-mile section of Arizona desert, if completely used, would be enough to power all the industry in the United States.

One way to use sunlight is to concentrate the rays. The United States Army, for example, operates a solar furnace in Massachusetts in which mirrors focus sunrays to a point hot enough to burn a hole through a steel beam. In fuel-poor India, the government has developed a solar cooker that can bring a stew to a boil in 10 minutes (see next page).

THE WASHINGTON POST

Another way to harness Old Sol is to collect its warmth. In a suburb of Washington, D. C., Harry E. Thomason has joined a growing number of experimenters adapting solar energy to everyday living. In his solar house (right), Mr. Thomason installed "heat traps" across half his roof and rear wall. Water flows across metal sheeting just beneath the glass panes, absorbs the sun's heat and carries it to a storage unit. Air blown over the stored heat warms the house. So well did the system work last winter that there was hot water left over to fill the wading pool for a dip.

In Albuquerque, New Mexico, a solar-heated office building has been in successful operation since early 1956. In Israel, several new apartment houses are heated by sun-power. In Japan, a recent count showed 200,000 solar water heaters helping solve that country's chronic fuel shortage.

Sunlight can be converted directly into electricity. Solar cells, like those in photographic light meters, now help carry telephone messages, power clocks, automatically set the lens opening on movie cameras—even push lawn mowers and operate highway blinkers and harbor navigation lights. Even more important, they furnish a lightweight power source for satellites far out in space. *Vanguard I* is still sending solar-cell radio signals to Earth after two years aloft. A.P.M.

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REACHING FOR THE SUN—New United States weather satellite, *Tiros I*, above, uses more than 9,000 solar cells to generate electricity to radio back to Earth pictures from its television cameras. At right, Indian girl fries a pancake, or *chapatti*, on a solar cooker, using fuel that originates 93 million miles away.

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